

2000-277794

(19) Japanese Patent Office (JP)

(12) Publication of Patent Application (A)

(11) Publication Number of Patent Application: 2000-277794 (P2000-277794A)

(43) Laid Open Date: October 6, 2000

5	(51) Int. Cl. <sup>7</sup>	Identification Mark	FI	Theme Code (reference)
	H01L 31/12		H01L 31/12	A 5F041
	31/10		33/00	L 5F049
	33/00		31/10	A 5F089
10	H04B 10/22		H04B 9/00	A 5K002
	10/00			

Request of Examination: not required

The Number of Claims: 7 OL (8 pages in total)

---

(21) Application No.: H11-77753

15 (22) Application Date: March 23, 1999

(71) Applicant: 000002369

Seiko Epson Corporation

2-4-1, Nishishinjuku, Shinjuku-ku, Tokyo

(72) Inventor: Tatsuya Shimoda

20 c/o Seiko Epson Corporation

3-3-5, Yamato, Suwa-shi, Nagano

(72) Inventor: Satoshi Inoue

c/o Seiko Epson Corporation

3-3-5, Yamato, Suwa-shi, Nagano

25 (74) Agent: Patent Attorney: Yoshiyuki Inaba (and two others)

Continued to last page

---

(54) [Title of the Invention] OPTICAL SIGNAL TRANSMITTING SUBSTRATE AND  
DEVICE

30 (57) [Abstract]

[Object] To provide a substrate and a device for transmitting optical signals which can lessen man-hours required for wiring and the cost required for wiring.

[Means for Solution] Individual optical signal transmitting substrates 1 are equipped with optical signal transmitting regions 100, in each of which at least one of a light emitting element E which transmits an optical signal to other optical signal transmitting substrates and a photo-detecting element D which receives an optical signal from other optical signal transmitting substrates is arranged capable of transmitting/receiving the optical signal in the direction substantially vertical to the substrate face. When stacking a plurality of these substrates, a photo-detecting element is arranged in one of the other optical signal transmitting substrates, so that it is counterposed to a light emitting element provided in one of the optical signal transmitting substrates.

[Scope of Claims]

[Claim 1] An optical signal transmitting substrate for transmitting optical signals characterized by comprising an optical signal transmitting region in which at least one of a light emitting element which transmits an optical signal to other optical signal transmitting substrates and a photo-detecting element which receives an optical signal from other optical signal transmitting substrates is arranged capable of transmitting/receiving the optical signal in the direction substantially vertical to the substrate face.

[Claim 2] The optical signal transmitting substrate in accordance with Claim 1 which is used with being sandwiched between other optical signal transmitting substrates, wherein the optical signal transmitting region is equipped with a transparent aperture with light transparency at a position through which an optical signal transmitted among other optical signal transmitting substrates passes.

[Claim 3] The optical signal transmitting substrate in accordance with Claim 1, wherein electrodes are equipped at least in a pair of edges of the substrate.

[Claim 4] An optical signal transmitting device which is configured by stacking a plurality of the optical signal transmitting substrates in accordance with any one of Claims 1 to 3 so that the optical signal transmitting regions of each substrate are

overlapped, characterized in that the photo-detecting element is arranged in one of the other optical signal transmitting substrates so that it is counterposed to the light emitting element provided in one of the optical signal transmitting substrates.

[Claim 5] In the optical signal transmitting substrate sandwiched between the  
5 optical signal transmitting substrate with which the light emitting element is provided  
and the optical signal transmitting substrate with which the photo-detecting element is  
arranged, the optical signal transmitting device in accordance with Claim 4, wherein a  
transparent aperture with light transparency is equipped at a position through which the  
optical signal transmitted between the light emitting element and the photo-detecting  
10 element passes.

[Claim 6] The optical signal transmitting device in accordance with Claim 4,  
wherein a plurality of groups comprised of the light emitting element and the  
photo-detecting element transmitting an optical signal are arranged in an optical axis of  
the optical signal.

15 [Claim 7] The optical signal transmitting device in accordance with Claim 4,  
wherein an adhesive layer comprised of electrodes for connecting electrodes of both  
substrates electrically and an adhesive is equipped between the optical signal  
transmitting substrates.

[Detailed Description of the Invention]  
20 [0001]

[Technical Field of the Invention] The present invention relates to an optical signal  
transmitting substrate in which input-output information is an optical signal. In  
particular, this invention relates to a substrate which is suitable for high-density  
mounting and an optical signal transmitting device using it, such as an electronic  
25 computer.

[0002]  
[Prior Art] Conventionally, in a device such as an electronic computer, a plurality  
of substrates required for constitution of a circuit are mutually connected by electric  
wiring using conductive lines such as cables and wires. The signal transmitted and  
30 received among substrates is an electrical signal generated by an interface element.

[0003] In some devices, optical signal transmission is also realized in which a light emitting element is provided on one substrate and a photo-detecting element is provided on the other substrate, and the mutual elements are connected with fiber optics.

[0004]

5 [Problem to be Solved by the Invention] The connection by using conductive lines is not suitable for wiring among substrates in the device of high-speed high-density mounting, since wiring capacity and wiring resistance exist and signal delay arises. There is also a disadvantage of producing fever by the wiring resistance.

10 [0005] As for connection by using fiber optics, in multiple wiring such as a bus, the number of fiber increases, man-hours of wiring are enormous and the cost required for wiring cannot but rise.

15 [0006] In order to deal with this disadvantage, it is an object of the present invention to lessen man-hours required for wiring and the cost required for wiring and provide a substrate and a device using it for transmitting optical signals which enable high-density mounting and high-speed communication.

[0007]

20 [ Means for Solving the Problems] In accordance with the present invention, an optical signal transmitting substrate for transmitting optical signals is characterized in that it is equipped with an optical signal transmitting region, in which at least one of a light emitting element which transmits an optical signal to other optical signal transmitting substrates and a photo-detecting element which receives an optical signal from other optical signal transmitting substrates is arranged capable of transmitting/receiving the optical signal in the direction substantially vertical to the substrate face.

25 [0008] When the optical signal transmitting substrate is used with being sandwiched between other optical signal transmitting substrates, the optical signal transmitting region of the optical signal transmitting substrate is configured so that it is equipped with a transparent aperture with light transparency at a position through which an optical signal transmitted among other optical signal transmitting substrates passes.

30 [0009] The optical signal transmitting substrate is preferably equipped with electrodes at least in a pair of edges of the substrate.

[0010] In accordance with the present invention, an optical signal transmitting device which is configured by stacking a plurality of the optical signal transmitting substrates as described above so that the optical signal transmitting regions of each substrate are overlapped, is characterized in that a photo-detecting element is arranged in one of the other optical signal transmitting substrates so that it is counterposed to a light emitting element provided in one of the optical signal transmitting substrates.

5 [0011] In this optical signal transmitting device, the optical signal transmitting substrate sandwiched between the optical signal transmitting substrate with which a light emitting element is provided and the optical signal transmitting substrate with which a photo-detecting element is arranged is preferably equipped with a transparent aperture with light transparency at a position through which the optical signal transmitted between the light emitting element and the photo-detecting element passes.

10 [0012] In order to realize high-density communication, a plurality of groups comprised of the light emitting element and the photo-detecting element transmitting an optical signal are preferably arranged in an optical axis of the optical signal.

15 [0013] In order to stack substrates, the optical signal transmitting device is preferably equipped with an adhesive layer comprised of electrodes for connecting electrodes of both substrates electrically and an adhesive between the optical signal transmitting substrates.

20 [0014]

[Embodiment Mode of the Invention] Next, one embodiment of the present invention is described with reference to drawings.

(Embodiment Mode 1) FIG. 1 shows a perspective view to describe a structure of an optical signal transmitting device in Embodiment Mode 1. FIG. 2 shows a plan view 25 of the optical signal transmitting substrate.

[0015] The optical signal transmitting device in this embodiment mode is configured by stacking a plurality of optical signal transmitting substrates 1 so that optical signal transmitting regions 100 of the substrates are overlapped in a plan view, as shown in FIG. 1. Although the laminated structure of five layers is shown in FIG. 1 to simplify 30 description, there is no limitation in the number of layers. Each optical signal

transmitting substrate 1 from a first layer to a fifth layer is referred to as 11 to 15 in FIG.

1. A distance between the optical signal transmitting substrates is within the distance that can transmit an optical signal between a light emitting element and a photo-detecting element. A plurality of substrates may be overlapped with those contacted directly, with spacers interposed therebetween, or with adhesive layers interposed therebetween.

[0016] In each optical signal transmitting substrate 11 to 15, a photo-detecting element DXY of one of the other optical signal transmitting substrates 1 is arranged so that it is counterposed to a light emitting element EXY provided in one of the optical signal

10 transmitting substrates 1. Here, "EXY" means a light emitting element for transmitting an optical signal from a substrate of Xth layer to that of Yth layer. "DXY" means a photo-detecting element for receiving the optical signal transmitted

15 from the substrate of Xth layer to that of Yth layer. A path which transmits and receives one optical signal in combination of the light emitting element EXY and the receiving element DXY is called a "channel." The light emitting element and the photo-detecting element belonging to the same channel are arranged at the same row and column in the optical signal transmitting regions 100 of the substrates. Hereinafter, a position of the optical signal transmitting region specified by the row and column is called an "address."

20 [0017] Specifically, the light emitting element EXY is arranged to be counterposed to the photo-detecting element DXY between the optical signal transmitting substrate 1 with which the light emitting element EXY is provided and the optical signal transmitting substrate 1 with which the photo-detecting element DXY is arranged so that the optical signal can be transmitted and received. When the optical signal

25 transmitting substrate 1 is sandwiched between the substrate with which the light emitting element is provided and the substrate with which the photo-detecting element is provided, the sandwiched optical signal transmitting substrate 1 is configured so that it is equipped with a transparent aperture T with light transparency at a position through which the optical signal transmitted between the light emitting element EXY and the photo-detecting element DXY in other substrates passes. The transparent aperture T is

arranged in the optical signal transmitting region 100 to the same address as the light emitting element EXY and the photo-detecting element DXY.

[0018] In FIG. 1, a light emitting element E14 on the optical signal transmitting substrate 11 (transmitting the optical signal from the first layer to the fourth layer) is counterposed to a photo-detecting element D14 on the optical signal transmitting substrate 14 (receiving the optical signal from the first layer in the fourth layer).  
5 Transparent apertures T are provided at a position through which the optical axis passes in the optical signal transmitting substrates 12 and 13 sandwiched between the both elements. Similarly, a light emitting element E51 on the optical signal transmitting substrate 15 is counterposed to a photo-detecting element D51 on the optical signal transmitting substrate 11. Transparent apertures T are provided at a position in which the optical axis intersects with the substrate faces in the optical signal transmitting substrates 12 to 14 sandwiched between the both substrates.  
10

[0019] A plurality of groups comprised of a light emitting element and a photo-detecting element transmitting an optical signal are preferably arranged in an optical axis of the optical signal in this invention. This is because high-density communication is realized. It is a case where a plurality of channels exist in the same row and column of the optical signal transmitting regions 100. In FIG. 1, a group comprised of a light emitting element E21 on the optical signal transmitting substrate 12 and a photo-detecting element D21 on the optical signal transmitting substrate 11 and a group comprised of a light emitting element E35 on the optical signal transmitting substrate 13 and a photo-detecting element D35 on the optical signal transmitting substrate 15 are arranged in the same optical axis, that is, the same address in the optical signal transmitting regions 100.  
15  
20

[0020] Each optical signal transmitting substrate 1 constituting the optical signal transmitting device is equipped with the optical signal transmitting region 100 in a part of a circuit region 110, as shown in FIG. 2. In the optical signal transmitting region 100, at least one of the light emitting element EXY which transmits an optical signal to other optical signal transmitting substrates and the photo-detecting element DXY which receives an optical signal from other optical signal transmitting substrates is arranged  
25  
30

capable of transmitting/receiving the optical signal in the direction substantially vertical to the substrate face. Furthermore, when the optical signal transmitting substrate is used with being sandwiched between other substrates, the optical signal transmitting region 100 is configured so that a transparent aperture T with light transparency exists at 5 a position through which an optical signal transmitted among other optical signal transmitting substrates passes.

[0021] There is no limitation in a material and thickness of the optical signal transmitting substrate 1. However, when the substrates are stacked, it is preferable to provide a bank or a spacer around so that an electronic element provided on the 10 substrate may not contact other substrates. There is also no limitation about a form and a forming method of a circuit provided in the circuit region 110. However, components of the circuit need to be arranged so that they may not exceed the maximum height of components specified with a bank, a spacer, or the like. Specifically, any circuits such as a processor circuit and a memory circuit of an 15 electronic computer and an integrated circuit of a TFT element are applicable. The light emitting element EXY can convert electrical signals such as a current or a voltage into an optical signal, and can apply any light emitting elements such as a semiconductor laser (a laser diode), a light emitting diode, and an organic EL element. The photo-detecting element DXY can convert a received optical signal into electrical 20 signals such as a voltage or a current, and can use photoelectric conversion elements such as a phototransistor or a photodiode.

[0022] The optical signal transmitting region 100 is the region in which the light emitting element EXY, the receiving element DXY, and the transparent aperture T can be arranged regularly. For example, the optical signal transmitting region 100 is 25 divided in a grid form, and the light emitting element EXY, the receiving element DXY, and the transparent aperture T are arranged in accordance with the division. The optical signal transmitting region 100 is configured by a material having the strength to the extent that the light emitting element EXY and the receiving element DXY can be arranged in any position.

30 [0023] For example, the optical signal transmitting region 100 can be formed using a

layer comprising transparent resin. When transparent resin is used as a basic material and the light emitting element and the receiving element are arranged, parts other than these elements have light transparency. Thus, it is not necessary to provide the transparent aperture T positively.

5 [0024] When the optical signal transmitting region 100 is formed using a material without light transparency, for example, the same material as the circuit region 110, a position corresponding to the transparent aperture T is opened, or an aperture through which light can transmit is formed.

10 [0025] The number of grids in the optical signal transmitting region 100 (the maximum number of channels) is defined corresponding to the number of channels of signals required between substrates. A position of the optical signal transmitting region 100 is arranged in any region on the substrate, and also the optical signal transmitting region 100 may be arranged in any shapes, such as a rectangle, a linear, and a circle. Additionally, it may be separated each to each to disperse in a point-like pattern in the circuit region 110, and arranged with being mixed with other circuits.  
15 The area of the optical signal transmitting region is appropriately set so as not to decrease the area of the circuit region 110 beyond necessity.

[0026] FIG. 3 shows an example of arrangement of the light emitting element EXY, the photo-detecting element DXY, and the transparent aperture T when the optical signal transmitting region 100 is configured by a total of 20 channels which are comprised of 5 vertical grids × 4 horizontal grids. A region applicable to none of the light emitting element EXY, the photo-detecting element DXY, nor the transparent aperture T may be with or without light transparency. Optical signal transmitting regions corresponding to optical signal transmitting substrates 11 to 15 from the first layer to the fifth layer are referred to as 101 to 105, respectively. Arrows show transmitting routes of optical signals in a column on the left hand in the figure. Injected light from the light emitting element EXY is assumed to have an ideal rectilinear propagation property and the photo-detecting element DXY is arranged adjacently in the drawing. However, when the light emitting element EXY whose rectilinear propagation property of injected light  
20 is not so good is used, it is necessary to prevent occurrence of a cross talk by arranging  
25  
30

the light emitting element and the photo-detecting element so that they may not be adjacent or providing a layer functioning as cladding in a boundary part between each optical signal transmitting region.

[0027] Various methods are applicable to a manufacturing method of the optical signal  
5 transmitting substrate.

[0028] For example, a release layer which produces ablation by laser light is provided  
on a transparent substrate such as glass, and the optical signal transmitting substrate of  
the present invention is formed on the release layer by a predetermined pattern.  
Subsequently, after bonding this optical signal transmitting substrate to another optical  
10 signal transmitting substrate with an adhesive, the release layer is irradiated with light  
from the transparent substrate side to produce separation and the transparent substrate is  
separated. This process is repeated in accordance with lamination number of the  
optical signal transmitting substrates.

[0029] Alternatively, after forming this optical signal transmitting substrate over a  
15 plurality of transparent substrates with a release layer interposed therebetween, two  
optical signal substrates are stuck together. Subsequently, laser irradiation is  
conducted from at least one side of the transparent substrates, and the transparent  
substrates are separated from the release layer. The optical signal transmitting  
substrate formed on another transparent substrate is stuck to the side from which the  
20 transparent substrate is separated, and laser irradiation is conducted from the transparent  
substrate side to separate the transparent substrate. This process is repeated in  
accordance with lamination number of the optical signal transmitting substrates.

[0030] A large number of optical signal transmitting substrates can be stacked  
certainly by using these manufacturing methods, although they are extremely thin.  
25 However, it is not limited to these manufacturing methods.

[0031] In accordance with Embodiment Mode 1, since the optical signal transmitting  
region for transmitting/receiving the optical signal is arranged in one part of the  
substrate in a direction substantially vertical to the substrate face, a simple method for  
transmitting/receiving a signal between substrates to arrange the light emitting element  
30 and the photo-detecting element properly and stack substrates can be provided.

[0032] In accordance with Embodiment Mode 1, since conductivity is not used, signal delay by wiring capacity and wiring resistance and fever by writing resistance are not produced.

5 [0033] In accordance with Embodiment Mode 1, since there is no need to connect between substrate with fiber optics, efforts required for connection and the cost required for fiber optics can be reduced.

10 [0034] In accordance with Embodiment Mode 1, since signal transmission between adjacent multilayered substrates can be realized easily in multichannel, it is most suitable as a signal transmitting method of a device using an electronic computer and a TFT of high-density and high-speed.

[0035] In accordance with Embodiment Mode 1, since transmitting/receiving by an optical signal is used, a transmitting device which is strong in noise and dose not generate unnecessary radiation can be provided.

(Embodiment Mode 2) Embodiment Mode 2 of the present invention relates to an 15 optical signal transmitting substrate and device in which power electrodes and earth electrodes are provided further in Embodiment Mode 1.

[0036] FIG. 4 shows a perspective view to describe a structure of the optical signal transmitting device in Embodiment Mode 2. FIG. 5 shows a plan view of the optical signal transmitting substrate.

20 [0037] The optical signal transmitting device in Embodiment Mode 2 is configured by stacking a plurality of optical signal transmitting substrates 2 so that optical signal transmitting regions 100 of each substrate are overlapped in plan views, as shown in FIG. 4. This optical signal transmitting device is different from the one in Embodiment Mode 1 in that it has an adhesive layer 3 between substrates. Although 25 the laminated structure of three layers is shown in FIG. 4 to simplify description, there is no limitation in the number of layers. Each optical signal transmitting substrate 2 from a first layer to a third layer is referred to as 21 to 23 in FIG. 4.

[0038] The adhesive layer 3 is configured by bonding and solidifying a first electrode 31 and a second electrode 32 counterposed with an adhesive 30 interposed therebetween 30 and the substrate 2. Any resins, for example, various hardening type adhesives such as

a reactive curing type adhesive, a thermosetting adhesive, a photo-curing type adhesive such as an ultraviolet curable adhesive, and an aversion hardening type adhesive can be given as the adhesive 30. Any adhesives such as an epoxy system, an acrylate system, and a silicon system can be applied as composition of such adhesives. Any metals such as aluminum, copper, and gold can be used as the first electrode 31 and the second electrode 32. The adhesive layer 3 is formed by hardening a metal rod whose shape corresponds to the first electrode 31 and the second electrode 32 with adhesives.

[0039] Each optical signal transmitting substrate 2 constituting this optical signal transmitting device is equipped with the same circuit region 110 and optical signal transmitting region 100 as Embodiment Mode 1, as shown in FIG. 5. However, it is different from Embodiment Mode 1 in that it is equipped with a first electrode 121 and a second electrode 122 at least in a pair of edges of the substrate. As for the first electrode 121 and the second electrode 122, it is convenient to conduct pattern formation using the same material as the wiring material used in the circuit region 110.

10  
15 However, in the optical signal transmitting substrate sandwiched between adhesive layers 3, electrodes are required to be formed so that the substrate may have conductivity between top/back faces of the substrate.

[0040] Arrangement and a configuration of a light emitting element EXY, a photo-detecting element DXY, and a transparent aperture T in the optical signal transmitting region 100 in each optical signal transmitting substrate 21 to 23 are the same as those of Embodiment Mode 1.

20  
25 [0041] FIG. 6 shows a side view of the optical signal transmitting device in this embodiment mode. First electrodes 121 of each optical signal transmitting substrate 21 to 23 and first electrodes 31 of the adhesive layer 3 contact electrically, and second electrodes 122 of each optical signal transmitting substrate 21 to 23 and second electrodes 32 of the adhesive layer 3 contact electrically. By stacking the optical signal transmitting substrate 2 and the adhesive layer 3 alternately, power electrodes and earth electrodes are wired mutually in this optical signal transmitting device.

30 [0042] Manufacturing methods of the optical signal transmitting device in this embodiment mode are conceivable variously.

[0043] When the optical signal transmitting substrate 2 is thick enough and has portability, the optical signal transmitting substrate can be manufactured in following processes.

1) The first electrode 31 and the second electrode 32 are connected on the optical signal transmitting substrate 2, and the resin is applied to form the adhesive layer 3.

5 2) The optical signal transmitting substrate 2 is stuck again on this adhesive layer, and the adhesive layer 3 is formed again thereon.

3) The optical signal transmitting device is configured by repeating these processes in accordance with required number.

10 [0044] When the optical signal transmitting substrate 2 is extremely thin and has no portability in itself, the optical signal transmitting substrate can be manufactured in following processes.

1) A release layer is formed on a base such as glass.

2) A circuit corresponding to the optical signal transmitting substrate 2 is formed on the  
15 release layer.

3) When the optical signal transmitting substrate 2 is formed, the adhesive layer 3 is formed thereon.

4) The release layer is irradiated with laser light from a back side of the base to produce separation and a combination comprised of the optical signal transmitting substrate 2  
20 and the adhesive layer 3 is separated.

5) The optical signal transmitting device is configured by stacking this combination in accordance with required total number.

Laser irradiation is conducted before forming the adhesive layer 3, and after forming the adhesive layer 3, it may be separated from the release layer by adding a force.

25 [0045] Embodiment Mode 2 has the same effect as Embodiment Mode 1, and also it can be easily connected to a power source and an earth terminal since electrodes are provided mutually on substrates.

[0046] In accordance with Embodiment Mode 2, since the substrates are stuck together by the adhesive layer, the multilayered laminated structure is formed easily and  
30 the strong optical signal transmitting device can be provided.

(Embodiment Mode 3) Embodiment Mode 3 of the present invention relates to a transformed example of the optical signal transmitting substrate in Embodiment Mode 2.

[0047] A plan view of the optical signal transmitting device in Embodiment Mode 3 is shown in FIG. 7. An optical signal transmitting substrate 4 in Embodiment Mode 3 has a complicated pattern of a first electrode 421 and a second electrode 422 getting into an optical signal transmitting region 400 and a circuit region 410, as shown in FIG. 7. Formation of this electrode pattern is conducted by patterning an electrode pattern in the optical signal transmitting substrate 4 to a shape required for the optical signal transmitting region 400 and the circuit region 410 and applying a forming method of a wiring pattern which is usually used.

[0048] As for a configuration of the optical signal transmitting device using this optical signal transmitting substrate 4, a light emitting element EXY and a DXY is arranged same as Embodiment Modes 1 and 2. The adhesive layer 3 of Embodiment Mode 2 can be used for adhesion of substrates.

[0049] Embodiment Mode 3 has the same effect as Embodiment Mode 1. In addition, since electrodes on the substrate are patterned, connection with a power electrode and an earth electrode of a circuit element is easy and so it is effective as measures against unnecessary radiation.

(Embodiment) As an embodiment in Embodiment Mode 2, an optical signal transmitting substrate as shown in a plan view of FIG. 8 is simulated. The first electrode 121 is used as a power (Vdd) electrode, and the second electrode 122 is used as an earth (GND) electrode. An X driver circuit 111 which supplies a power source in a row direction (X-axis direction) of the optical signal transmitting region 100 and a Y driver circuit 112 which selects a column direction (Y-axis direction) of the optical signal transmitting region 100 are provided. A logic circuit 113 comprising a memory circuit 114 is provided in the circuit region. TFT is accumulated as the logic circuit 113. Specifications of the embodiment are as follows.

Lamination number of substrates: 1000

Thickness of a substrate and an adhesive layer: about 10  $\mu\text{m}$ /set

Address number (the number of apertures):  $1000 \times$  about  $10^6$  (accumulation number per substrate)

Area of an address:  $50 \times 50 \mu\text{m}^2 = 2.5 \times 10^3 \mu\text{m}^2$

Optical signal transmitting region area: address area  $\times$  accumulation number =  $25 \text{ cm}^2$

5 Optical signal transmitting substrate outline:  $7 \text{ cm}$  (length)  $\times$   $14 \text{ cm}$  (width) =  $98 \text{ cm}^2$

Manufacturing cost per area:  $20/\text{cm}^2$  yen

Manufacturing cost per substrate: 2000 yen

Manufacturing cost of device: 2000000 yen

Area of one TFT:  $4 \mu\text{m}^2$

10 TFT number per substrate: about  $9 \times 10^8 = 1 \text{ G}$

(Other transformed examples) This invention can be applied by being transformed variously without being limited to the above-mentioned embodiment mode. For example, an optical signal transmitting substrate, an optical signal transmitting region, an external shape of electrode, and arrangement of an optical signal transmitting region is only an example.

15 [0050] An optical signal transmitting device is sufficient if optical signal transmitting regions are overlapped to conform each address when they are overlapped parallel to a vertical face to an optical axis of an optical signal, and it does not require that substrates in themselves are conformed. As shown in FIG. 9 for example, if arrangement of 20 optical signal transmitting regions is different in each substrate, signal transmission is possible as long as the regions are overlapped correctly.

[0051]

25 [Effect of the invention] In accordance with this invention, since the optical signal transmitting region is provided on laminated substrates and groups comprised of the light emitting element and the photo-detecting element which can transmit the optical signal are provided between substrates, man-hours required for wiring and the cost required for wiring can be lessened. By such configuration, high-density mounting and high-speed communication can be realized.

[Brief Description of the Drawings]

30 [FIG. 1] A perspective view to describe a configuration of an optical signal transmitting

device in Embodiment Mode 1.

[FIG. 2] A plan view of an optical signal transmitting substrate in Embodiment Mode 1.

[FIG. 3] A drawing to describe combination of a light emitting element and a photo-detecting element in Embodiment Mode 1.

5 [FIG. 4] A perspective view to describe a configuration of an optical signal transmitting device in Embodiment Mode 2.

[FIG. 5] A plan view of an optical signal transmitting substrate in Embodiment Mode 2.

[FIG. 6] A side view of an optical signal transmitting device in Embodiment Mode 2.

[FIG. 7] A plan view of an optical signal transmitting substrate in Embodiment Mode 3.

10 [FIG. 8] A plan view of an optical signal transmitting substrate of an embodiment.

[FIG. 9] A drawing to show a transformed example of a laminating method of an optical signal transmitting device.

[Description of Signs]

E...light emitting element

15 D...photo-detecting element

T...transparent aperture

1, 11-15, 2, 21-25, 4...optical signal transmitting substrate

3...adhesive layer

100-105...optical signal transmitting region

20 110...circuit region

121, 31...first electrode

122, 32...second electrode

---

Continuation of the front page

25 F term (reference)

5F041 AA02 AA42 AA43 CA91 DC81

DC91 FF14 FF16

5F049 MA01 MA11 NA03 NA09 NB01

NB10 RA02 SE11 SE20 UA01

30 UA17

2000-277794

5F089 AA01 AA07 AB03 AC02 AC05

AC07 AC08 AC10 FA06

5K002 AA07 FA03 GA06 GA07